

Day One: Second Workshop on Systems-Driven Approach for Inverter R&D
Radisson Cross Key Hotel, Baltimore, MD, October 13-14, 2004
Preliminary Agenda

Sponsors: DOE Office of Energy Efficiency and Renewable Energy, Solar Energy Technologies Program
DOE Office of Electric Transmission and Distribution, Energy Storage Program

Objective: This is a follow-up to the first systems-driven approach workshop on inverter R&D held in April 2003. Participants will use a similar methodology to explore in greater depth the *next generation of high-tech inverters* for PV and energy storage technologies and synergistic applications. Your insights will guide the “High-Tech Inverter R&D 5-Year Strategies” document that will be completed by the beginning of fiscal year 2005, a key by-product of this workshop.

The second day of the workshop will examine inverter-related standards, codes, and certifications currently available or being drafted and will include discussions of the economic and technical impacts on inverter designs today. Needs for future standards, codes, and certification, along with inputs from the standards writing groups and the inverter/systems industry, will be discussed and prioritized.

Day 1: Inverter Technology Discussion

7:30 – 8:00 Sign-in, Breakfast Buffet

8:00 – 8:15 Welcome, Outline of Workshop Goals, Guidelines for the Workshop (Ray Sutula, DOE)
[Discuss importance of 5-year strategy, value of the input from the meeting to managing the program and directing R&D]

8:15 – 8:30 Introduction to Energy Storage Inverter Issues and Ongoing Work (Imre Gyuk)
[Research and priorities of the Energy Storage Program and its relation to inverter development – why inverter technology is important to our program, what we are doing to advance the state of the art]

8:30 – 8:45 The Systems-Driven Approach Status and Update (Chris Cameron, Sandia)
[Focus on the inverter elements of the SDA – the importance of the shift toward looking at the whole PV system for focusing on the importance of inverter and control technology. Understanding market realities is at the heart of the SDA, which includes the practical codes issues. Codes and standards discussions on second day will shape SolarAdvisor modeling and technology forecasting.]

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- 8:45 – 9:00 High-Tech Inverter Research & Development: A Five-Year Strategy
(Ward Bower, Sandia)
- [Benefits of strategy for galvanizing research, current status and key elements of the strategy, what is needed from this meeting to make it complete, how it will be used, and how the results of this meeting will have an impact]*
- 9:00 – 9:45 High-Reliability Inverter Initiative Status Update
- 9:00 -- 9:15 Xantrex
9:15 – 9:30 GE
9:30 – 9:45 SatCon
- [For each presentation at the minimum the objective of the research; milestones accomplished; funding; significance of the research and the results for improving technology and market potential; highlights or surprising findings; opportunities for further research – what should come next]*
- 9:45 – 10:15 Questions, Answers, Discussion (Moderator)
- [Questions open for Chris Cameron, Ray Sutula, Imre Gyuk, Ward Bower and High Reliability Inverter presentations. Staff to record questions and answers as they occur.]*
- 10:15 – 10:30 Break
- 10:30 – 12:15 High-Tech Inverter Issues and Needs
- 10:30 – 10:50 Capacitor Technologies: A Comparison of Competing Options (Bruce Tuttle, Sandia)
- [What are main points of comparison -- cost, performance? Technological maturity of competing options, current applications experience, implications for other inverter elements – codes and standards implications? Include capacitor issues/technologies for large inverters (>500 kW)]*
- 10:50 – 11:10 Thermal Management and Packaging Techniques and Advances (Clayton Hamilton, Heliotronics)
- [Nature of thermal management problems, different approaches being applied, cost/performance and other parameters for analysis, implications for other inverter components – codes and standards implications?]*

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11:10 – 11:30 Surge Protection for Inverters, Status and Needs (Michael Ropp, South Dakota University)
[Operating environment and requirements, options and main tradeoffs in cost/performance/design, implications for other inverter components and costs, codes and standards issues related to surge protection]

11:30 – 11:50 Communications and Controls for Inverters (Frank Goodman, EPRI)
[Current status, where communications and controls may be headed based on market trends – distributed generation, advances in energy management systems. Protocol, standardization and interface challenges. Main competing technologies and approaches – upgradeability, disposability. Implications for performance and cost of inverter/system package.]

11:50 – 12:15 Power Electronics (Jeff Casady, SemiSouth)
[Current options and major trends in development. Role of advanced power electronic devices in system performance and cost. Key parameters – what are the characteristics of power electronics that are most important and can be influenced by R&D? Comparison of technologies for large and small scale inverters. Long- and short-term cost implications]

12:15 – 12:30 Questions and Answers (Moderator)
[Bring presenters back as a panel to answer questions]

12:30 – 1:30 Lunch, Buffet Style

1:30 – 3:15 Parallel Breakout Sessions A through C for Status, Goals, and Needs of These Parameters:

- Efficiency
- Reliability/durability
- Cost
- Maintenance/maintainability
- Manufacturability
- Cross-technology application

[An important prioritization goal for all breakout sessions is a three-dimensional matrix mapping technologies (wide band-gap devices, capacitors, surge protection, large scale integrated devices, communication modules, etc.) with key influences (temperature, energy, power, packaging, interfaces, standards, certifications, etc.) with respect to a R&D time line.]

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Parallel Breakout Session A – Capacitor/Component Technologies

Parallel Breakout Session B – Surge Protection, Thermal Management,
and Packaging

Parallel Breakout Session C – Power Electronics, Communications, and
Controls

[1:30 to 1:45, break people into groups and organize how groups will operate. Approximately 30 people per breakout. Have staff from Laboratory and DOE assigned to appropriate groups beforehand so they can help move the discussion along. Lab and DOE should take the role of contributors, but try to avoid leading or dominating discussions. Each breakout will have a moderator and a recorder provided by McNeil. One laboratory person will also be asked to take notes in order to be sure highly technical information is captured accurately.]

[1:45 to 2:00 Discuss current goals and topics in research. For each panel a chart should be prepared showing where DOE has already developed goals and objectives. This will be the starting point for discussion. First, ask whether the parameters for each breakout topic are appropriate – is efficiency really relevant to communications, controls and power electronics? Define the parameters that are most important for each breakout group, adding additional items as necessary. Keep the list of critical parameters down to as few as possible. It is likely someone will ask what we are designing for – PV is the focus of this meeting but is not the only, or in some cases the primary, driving force in technology development. (Adding Energy Storage changes this. ES systems are on the order of 10's of KW-10's of MW) We should ask them to bring it back to solar as much as possible.]

[2:00 to 2:30, Ask the group to break up into 4 smaller groups to address the parameters. Because there are tradeoffs between efficiency and cost, cost and reliability, etc., each group will be asked to address all the parameters. The group can decide if they want to break the technology issues out separately – for example one group on communications, one on controls and another on power electronics, if that makes sense. Each smaller group will first describe the current status of technology. Then they should develop what the goals should be in 2010 and 2015 for each parameter. Then they should decide what is needed to accomplish the goal, and how it can be done. They can start with DOE's goals as a takeoff point. They should prioritize once they have captured all the information – the objective is to identify the most critical parameters.]

2:30 – 2:45 Break *[During break staff should label the summary sheets clearly as to which session they are from and apply a numbering system to the goals/actions. For example Group A's first goal/action would be A1, the second A2, etc., Group B's would be labeled B1, B2, etc.]*

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- 2:45 – 3:30 Resume Parallel Breakout Sessions
[Reassemble the breakout groups and discuss the status, goals and needs discussion from the small groups. Identify where there is agreement/consistency. These are the core results. Identify where there are disagreements or where a group developed something unique. Discuss these and if the group agrees consolidate the information into the consensus findings. If there is time discuss whether there are inconsistencies between goals, where there are tradeoffs that should be made explicit, how realistic the goals are, etc...Make modifications where necessary in preparation for presentation to whole group, allow group to choose spokesperson.]
- 3:30 – 4:15 Session Summaries (Various Moderators)
[3:30 to 3:45, Breakout Group A summarizes the current status of Capacitor Technology, proposed goals for 2010 and 2015, and how to accomplish them. Leave 5 minutes for questions and answers]
[3:45 to 4:00, Breakout Group B summarizes the current status of Surge Protection and Thermal Management Technology, proposed goals for 2010 and 2015, and how to accomplish them. Leave 5 minutes for questions and answers]
[4:00 to 4:15, Breakout Group C summarizes the current status of Communication, Control and Power Electronics Technology, proposed goals for 2010 and 2015, and how to accomplish them. Leave 5 minutes for questions and answers]
- 4:15 – 5:15 Summary Presentations And Discussions--Prioritization, Sequence, Critical Paths
[Ask everyone to reflect on the session summaries and take a few moments to rank the activities in order of priority on their notepads – start with Session A, then do Session B, then do Session C. This will be a check and affirmation of the priorities developed in the breakouts. Ask the group to hand them in at the end of the discussion. It is okay to modify them as we speak, and it is okay to put your name on them.]
[Discussion – are there sequence issues here? Do some of these items have to happen before others are possible? We are looking for critical paths and bottlenecks that have to be addressed. Or is this a Rubik's cube problem, where adjustments are inherently part of a whole system that reacts to changes in any one element?]
- 5:15 – 6:45 Reception
[No meeting business, just networking and socializing. There are plenty of attractions and restaurants at the Inner Harbor for people to enjoy afterward]

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Day 2: Codes, Standards and Applications in the Real World

- 7:30 – 8:15 Breakfast Buffet
- 8:15 – 8:30 Review of Day 1, Questions/Answers/Parking Lot (Moderator)
[Staff will record comments on previous day as they occur.]
- 8:30 – 8:55 National Electrical Codes and Other Standards in the Real World – Horror Stories, Successes, and Looking Forward to 2005 (John Wiles, SWTDI)
[This should remind everyone that codes and standards have real impacts – on consumers, on manufacturers, installers in the field, utilities, regulators and inspectors. Sometimes the results of small changes in wording are completely unexpected. We need to keep our eye on practical impacts as we discuss the issues today, and as we look forward to the issues coming up in 2005.]
- 8:55 – 9:15 Overview of UL1741 Changes and Additions (Tim Zgonena, Underwriters Laboratories)
[Describe the changes and additions, then to the extent possible their implications for manufacturers, consumers, utilities, installers. What key problems does it solve, are there new issues it brings up, how will it be implemented and when?]
- 9:15 – 9:45 Review of IEEE Standards for Inverters: IEEE 1547.1 Test Procedures, IEEE 1547.2, IEEE 1547.3 Communications Protocol (Tom Basso, NREL)
[Describe the changes and additions, then to the extent possible their implications for manufacturers, consumers, utilities, installers. What key problems does it solve, are there new issues it brings up, how will it be implemented and when?]
- 9:45 – 10:00 Break
- 10:00 – 10:30 Review of IEEE Standards for Inverters, Continued
- 10:30 - 10:50 Overview of IEC Inverter Standards (Christoph Panhuber, Fronius)
[Describe the changes and additions, then to the extent possible their implications for manufacturers, consumers, utilities, installers. What key problems does it solve, are there new issues it brings up, how will it be implemented and when?]
- 10:50 – 11:10 Certification of Inverters: Does It Make Sense? (Chuck Whitaker, Endecon Engineering)
[Pros and cons of certification. Practical issues involved in implementation. Who would certify? Who would pay for it? How much

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would it cost? What are the pros and cons from the perspective of manufacturers? Consumers? Regulators? Utilities?]

11:10 – 11:30 DUIT Multiple Inverter Testing Results (Susan Horgan, Distributed Utility Associates)
[Probabilities and impacts of multiple distributed resources connected to utility distribution systems]

11:30 – 11:50 State-By-State Rules: California Rule 21- Does It Take Precedence Over Interconnect Standards? (Bill Brooks, Endecon Engineering)
[What do we know for sure about the rule and its application, and what is still unclear? Why is it important? Who does it impact? Is the precedent of a state-level rule like this good or bad – should it be standardized across states? Could this be the model for implementation across states, for good or bad?]

11:50 – 1:00 Lunch

1:00 – 3:00 Parallel Breakout Session A–UL Standards Related Issues and Needs
Parallel Breakout Session B–Utility Related Standards Issues and Needs
Parallel Breakout Session C–Inverter Manufacturers Issues and Needs
[1:00 to 2:00. For each breakout panel ask the group to identify issues/needs. Then give them 5 stickers each and ask them to go and rate them in terms of priority. Summarize the results of the voting.]
[2:00 to 2:45. Group discussion of responses to issues/needs – what can be done, who is needed to do it, and which issues/needs do the suggested actions address? Start with the top priority items and work down.]
[2:45 to 3:00. Ask group to prioritize responses in cases where there is more than one option. What needs to be done first, what has the best chance of success? Ask group to pick a spokesperson before taking break.]

3:00 – 3:15 Break *[During break moderators work to summarize results]*

3:15 – 3:45 Session Summaries (Various Moderators)
[3:15 to 3:30 summary of issues/needs for UL Standards, and responses.]
[3:30 to 3:45 summary of issues/needs for Utility Related Standards, and responses.]
[3:45 to 4:00 summary of issues and needs for Inverter Manufacturers, and responses]

3:45 – 4:30 Summary Presentations And Discussions–Priorities, Sequence, Critical Paths
[Since the breakout groups were organized around groups there has to be some discussion of where there may be conflicts in issues/needs and responses to codes and standards for consumers and insurers (UL group), utilities and manufacturers. Where are the disagreements? Where is there

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consensus? Then the discussion should consider priorities among the group reports, and identify any problems with sequence/bottlenecks.]

- 4:30 – 5:00 What's Next? Working Groups, Review of Outputs, Coordination with other Stakeholders.
[Considering the outputs from today's meeting, are there volunteers for working groups to follow through on the actions? What stakeholders were missing? How do we involve them? Who wants to be involved in the 5-Year Strategy?]